Energy Competence Centre

System Integration : Track V
Zero-Energy in the Built Environment: the bottom-up approach!

Jan B. de Wit
1. Basics
2. Concepts and examples
3. Integrated concepts
4. Concept – design - implementation
1. Basics

- The best energy demand = no energy demand
- The Energy Chain
- Trias Energetica
- Exergy: minimize temperature drops, apply LT systems for heating and cooling

*Sustainable (Zero-) Energy in the whole chain: Bottom-up Approach!*
The energy Chain – Top-Down

Fossil input

Oil & Gas mining

production

transport

distribution

Centralized conversion

Accumulated solar heat

Decentralized conversion losses

Heat recovery

local conversion

Heat

electricity

End use

Sun, Wind

Fule from biomass (Bio ethanol, H₂, CH₄, etc)

centralized conversion losses

Accumulated solar heat

End use

Sun, Wind

Fule from biomass (Bio ethanol, H₂, CH₄, etc)
The energy Chain – Bottom-Up

Accumulated solar heat (water, soil, PCM, TCM)

Delivered from/to the grid

Heat recovery

Sun, wind

End Use

Electricity

Heat
Trias Energetica is a way of dealing with energy.

Trias Energetica is a simple and logical concept that helps to achieve energy savings, reduce our dependence on fossil fuels, and save the environment.

The 3 elements of Trias Energetica are:

1. Reduce the demand for energy
2. Use sustainable sources of energy instead of finite fossil fuels;
3. Produce- and use fossil energy as efficiently as possible.
Trias Energetica

(Clean) fossil fuels

Apply Sustainable Energy

Reduce Losses

with maximum efficiency

From inside: Bottom-up!
1) Reducing energy demand **versus** 2) Alternative energy supply

- **Present situation**
- **Alternative Energy Supply** (HP, PV, DH, micro-CHP, Solar, etc)

**Energy Demand** (Isolation, heat Recovery)

- Zero level
- Energy consumption (year)
- Energy production (year)

**Nett energy consumption**

**Nett energy production**
But... there is more than Trias Energetica.....

Temperature = Quality = Exergy!

1) Heat - \( T = T_{\text{ambient}} \) = 0 % Exergy

2) Electricity = 100 % Exergy
Exergy, Micro CHP and Heat Pumps

- CHP
  - Electricity
  - Heat
  - Radiator
  - Natural gas
  - Less heat delivered

- Micro CHP

- HP
  - Electricity
  - Heat
  - Radiator
  - Heat Pump
  - Less electricity required

- Environment temperature ($T_{\text{environment}}$)
Trias Exergetica : bottom-up!

- Get exergy from environment
- Minimal exergy losses
- By conversion from (clean) fossil fuels

MINIMISE TEMPERATURE DROP

...PV!
2. Sustainable concepts

- Usual and new (HVAC) concepts
- Zero energy buildings in The Netherlands
Usual HVAC concepts

- Heat recovery
- H/C storage (soil) + LTH + HP
- Sun (PV, Thermal/HSW)
- Home automation
- Hotfill
- Advanced HVAC control systems
- Micro CHP
New Concepts

Innovation in Buildings

- Integral design tools
- New building & isolation materials
- New concepts for heat/cold storage
- Active building skin
- 12/24 V DC Buildings (PV + local storage)
New concepts

- Innovative HVAC
  - Integrated domotics
  - Self adjusting systems
  - Integrated HVAC systems
  - Intelligent Hotfill systems
  - Broadband Heat Pump systems
  - Micro CHP with high E efficiency (FC)
  - Decentralised HVAC systems in (large) buildings
  - PVT and adaptive PV systems
  - Mixed Micro CHP and HP systems
Zero Energy House Threat 1: Exceeding Room Temperatures

15 visitors

Room temperature

35

20
Zero Energy House Threat 2: Poor ventilation, CO$_2$ excess
Zwaagwesteinde  EPC = 0,02  ( EPC = 0,8 is obliged ) Modern Duplex
PV system, LT heating system Heat Pump
Kollum
Traditional House
EPC = 0,
LT/heat pump system,
PVT system,
Triple window-glass
SNEEK
Modern Estate, EPC = 0.04,
Heat pump/LT heating system,
PV system
### Zero energy buildings in The Netherlands

<table>
<thead>
<tr>
<th>Project</th>
<th>House</th>
<th>Construction</th>
<th>EPC</th>
<th>Isolation skin</th>
<th>U value</th>
<th>Heating system</th>
<th>Heat delivery system</th>
<th>Ventilation system</th>
<th>Sun (PV)</th>
<th>Solar (thermal) for hot sanitary water</th>
<th>Shower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zwaagwesteinde</td>
<td>24 X 2/1 kap</td>
<td>Wood frame</td>
<td>0,02</td>
<td>5--4--5</td>
<td>1,2--1,47</td>
<td>combi WP</td>
<td>balanced + WTW</td>
<td>yes</td>
<td>no</td>
<td>ja</td>
<td></td>
</tr>
<tr>
<td>Sneek</td>
<td>1 X free standing</td>
<td>Wood frame</td>
<td>0,04</td>
<td>4.6--4--4.8</td>
<td>1,8--3,4</td>
<td>combi WP</td>
<td>balanced + WTW</td>
<td>35 panels</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
</tr>
<tr>
<td>Kollum</td>
<td>2 X free standing</td>
<td>Wood frame</td>
<td>0</td>
<td>5--5--5</td>
<td>0,8-- ?</td>
<td>combi WP</td>
<td>balanced + WTW</td>
<td>PVT m2= ?</td>
<td>PVT m2= ?</td>
<td>nee</td>
<td></td>
</tr>
</tbody>
</table>
3. Integrated concepts

1. CHP + HP in existing and new built houses
2. ‘Energy producing Greenhouse’
It takes two to tango!!

**Micro CHP**  Combined with  **Heat pump**

- **House 1**
  - ✓ Existing house
  - ✓ Hotfill

- **House 2**
  - ✓ New built very low energy house

- Natural gas
- **Heat**
- **Electricity**

- **Electricity**

- **Electricity**

- **Electricity**
Energy producing Greenhouse
4. Concept – Design - Implementation

- Classical (top down) approach
- New (bottom-up) approach
**Classical (Top-down) approach:**

- Concept phase: architectonic concept & construction -- no climate concept

- Design phase: at first architectonic design & construction = climate concept & design is secondary

- Implementation phase: Installation of HVAC units in the final stage of building realization.

**Result of the classical top-down approach:**

Poor indoor climate, abundant energy consumption and sick building syndrome
The new (Bottom up) approach:

- Concept phase: Interaction of architectonic concepts/construction and sustainable climate concept

- Design phase: integral design of the building and the HVAC systems to reach an optimal indoor climate and a minimum of energy consumption

- Implementation phase: construction and HVAC installation in an optimized schedule

Result of the bottom-up approach:

Low energy consumption and an agreeable indoor climate
The end